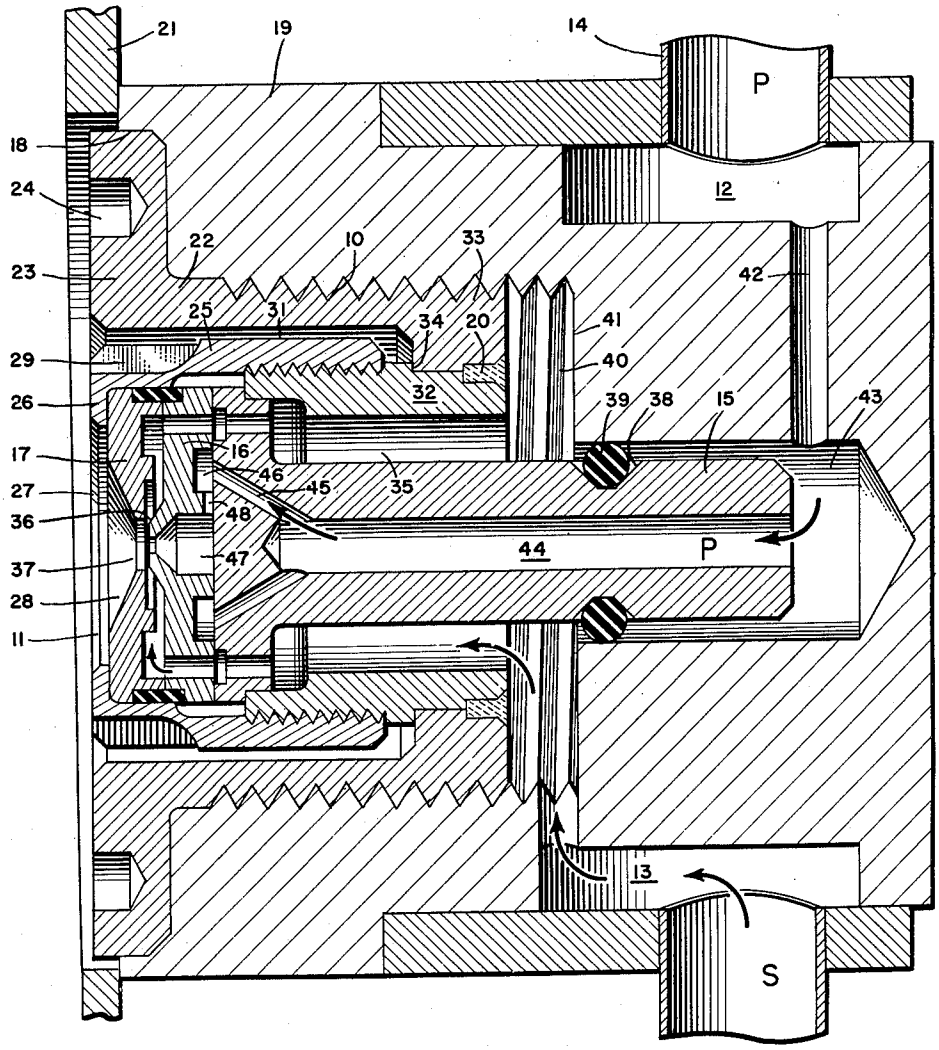
Nov. 12, 1957 L. S. BILLMAN 2,812,978

FUEL INJECTION SYSTEM FOR RAMJET AIRCRAFT

Original Filed Feb. 9, 1955

FIG. 1



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United States Patent Office 2,812,978 Patented Nov. 12, 1957

2,812,978

FUEL INJECTION SYSTEM FOR RAMJET AIRCRAFT

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Original application February 9, 1955, Serial No. 487,227. Divided and this application June 29, 1956, Serial No. 598,225

2 Claims. (Cl. 299—107.1)

The present invention relates to a fuel injection system for ramjet engines and more particularly to a fuel injection system for ramjet engines having two-stage fuel injector nozzles radially mounted within the diffuser inner body.

This application is a division of copending application Serial No. 487,227, filed February 9, 1955.

It has been found that two-stage fuel injector nozzles are usually required in a ramjet, especially in ramjets which are to encounter a wide range of flight speeds and altitudes. Two-stage fuel injector nozzles have in actual practice attributed a good atomization of the fuel over a broad fuel flow range. This important characteristic of the two-stage nozzle has enabled ramjet fuel combustion to take place in a manner such that uniform burning of a large percentage of the total atomized fuel present in the combustion chamber is possible. The atomized fuel-air mixture is maintained substantially homogeneous by the arrangement of the nozzles about the diffuser inner body walls.

Known methods of mounting fuel injector nozzles flush with the combustion chamber wall of supersonic aircraft involve stationing the fuel manifolds for injectant orifices circumferentially without the combustion chamber wall in relationship to the fixed position of the fuel igniter or holder located within the chamber. It is difficult to achieve a homogeneous fuel-air mixture when the fuel is injected into the combustion chamber from such nozzles, because the mass-air flow generally establishes a boundary layer of air with the inner surface of the combustion chamber wall. The presence of the inner surface boundary layer of air restricts the flow of high velocity mass-air toward the center of the chamber due to the turbulent frontal area produced by the boundary layer of air in frictional contact with the chamber walls. Therefore, when the injectant is introduced into the air stream of the combustion chamber, the fuel-air ratio is heterogeneous in any cross-sectional area of the chamber. The consistency of fuel-air mixture changes from a rich mixture in the boundary layer zone to a lean mixture in the high velocity mass-air flow zone irrespective of the fuel injection pressure, and a nonuniform fuel mixture inhibits smooth thrust characteristics of the ramjet.

The present invention overcomes the above-mentioned prior art deficiences of fuel injection systems for ramjets by the provision of a multipoint radial fuel injection system which includes two-stage fuel injector nozzles to vary the fuel-air mixture in accordance with flight speed and altitude demands. The radial injection system is mounted in a manner which contributes to a substantially homogeneous fuel-air mixture available in a major portion of the combustion chamber.

An object of the present invention is the provision of a fuel injection system for ramjets which contributes combustion characteristics favorable for uniform thrust of ramjets.

Another object is to provide a fuel injection system for ramjets which includes two-stage fuel injector nozzles

annularly mounted within the diffuser inner body to achieve a substantially homogeneous fuel mixture throughout the combustion area of the chamber.

Another object is the provision of valve operating apparatus for flush skin mounted fuel injector nozzles which permits two-stage nozzles to be operated within the restricted area of a ramjet diffuser inner body.

Still another object of the present invention is to provide a valve actuating system which permits metering of fuel to the injector nozzles of the ramjet power unit.

A further object is the provision of a fuel injection system for ramjets wherein the fuel nozzles are mounted inside the inner body of the diffuser flush with the skin thereof to improve atomized fuel mixing and to permit ram air to pass through the diffuser air passage without interruption by fuel lines and nozzle support structure.

Another object is to provide a two-stage fuel injector nozzle having readily adjustable components which attribute to ease of serviceability of critical areas of the nozzle.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing wherein:

Fig. 1 shows a sectional view of a preferred embodiment of the invention.

Referring now to the drawing there is shown a two-stage fuel nozzle **11** having a primary fuel inlet port **12** and a secondary fuel inlet port **13** each communicating with a fuel manifold, not shown, by suitable piping **14**. The nozzle body is substantially comprised of a nozzle stem **15**, a stem cap **16**, and an orifice front piece **17**, each being in superjacent relation on a mutual axis. The nozzle **11** is adjustably mounted by suitable means such as screw threads **10** into tapped openings **18** of ramjet support structure such as the diffuser inner body **19** flush with the diffuser surface **21** by means of an externally threaded casing member **22** having an annular collar flange **23** at one extremity thereof and provided with tool openings **24** in the flange for ease of manipulation or adjustment of the casing member **22**. The collar flange **23** is faired to form a continuance of the surface to which it is flush mounted.

An intermediate internally threaded clamping sleeve **25** is coaxially spaced apart from the externally threaded casing member **22** and is provided at one end with an inwardly directed annular flange **26** having a tapered surface **27** which constitutes the outermost portion of the progressively enlarging frustro-conical nozzle orifice generally denoted as element **28**. The annular flange **26** serves to frictionally clamp the orifice front piece **17** and the stem cap **16** into their relative positions within the nozzle component arrangement. Tool mating indentation surfaces **29** are circumferentially located on the outermost cylindrical wall section **31** of clamping sleeve **25** which permits the removal of the nozzle orifice components such as elements **16** and **17** without the necessity of dismantling the entire nozzle from its support structure to service the orifice components.

An inner sleeve **32** is threadedly engaged to clamping sleeve **25** and coaxial therewith. Sleeve **32** is attached to the lowermost section **33** of casing **22** by suitable means such as annular weld **20** thus firmly seating the recessed surface **34** of inner sleeve **32** to orient the casing **22** and sleeve **25** into their proper alignment with regard to the orifice front piece **17**, stem cap **16**, and nozzle stem **15**.

The secondary fuel feed from the secondary inlet fuel port **13** to the orifice **28** of nozzle **11** is accomplished by providing an annulus **35** surrounding the stem **15**

which is aligned with a plurality of holes provided in companion flanges of the stem **15** and stem cap **16** and laterally to a central deflecting surface **36** of cap **16** in registry with a central aperture **37** provided in the orifice front piece **17**.

A circumferential recess **38** on the lower portion of nozzle stem **15** receives a seal **39** which frictionally engages the walls of the ramjet support structure **19** to effectively divide the path of the primary fuel flow from the path of the secondary fuel flow. Vertical spacing of casing **22** and sleeve **32** above the ramjet support structure shoulder **41** forms an area **40** which restricts the secondary fuel flow from the inlet port **13** to the annulus **35**.

An inwardly directed channel **42** formed in the ramjet support structure **19** introduces the primary fuel from inlet port **12** to the bore **43**. Stem **15** of nozzle **11** is provided with a longitudinally extending hollow center **44** which serves as a primary fuel conduit, and which is furcated at its upper extremity to form a plurality of passages **45**.

Passages **45** connect the hollow center **44** of stem **15** with a circumferentially spaced stem cap annulus **46** which communicates with a centrally positioned nozzle chamber **47** within stem cap **16** by means of lateral passageways **48**. Chamber **47** decreases in diameter to direct the primary fuel under pressure through the central aperture **28** of the orifice front piece **17** of nozzle **11**.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A flush fuel injection nozzle mounting comprising: an internally threaded housing, a first cylindrical member externally threaded to engage said housing and having a tool engageable collar on its outer end and a re-entrant flange on its inner end, a second cylindrical member having one end fastened to the inner wall of said flange and external threads at its other end, a third cylindrical member having a tool engageable re-entrant flange at one end and threaded at the other to engage the threads of said second cylinder whereby the nozzle components may be removably mounted between the threaded end of the second cylinder and the re-entrant flange of the third cylinder.

2. A mounting for flush skin fastening of fuel injection nozzles in a ramjet diffuser inner body comprising; a first cylindrical sleeve having a tool engageable collar at the outer end thereof and a re-entrant flange at the other end thereof, said sleeve being receivable into the inner body such that said tool engageable collar is even in surface with the diffuser inner body surface, and a pair of inner cylindrical sleeves for removably positioning said nozzle mutually engageable and concentrically positioned by said first sleeve re-entrant flange.

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